Relative Advantages of Paper Tape Versus Punch Cards

I. PURPOSE:

This paper compares the relative advantages of paper tape versus punch cards to produce a machine language by-product during a normal typing operation.

II. DISCUSSION:

The specific application of concern here involves the production of the 3 x 5 cards now being typed in SRD for insertion in the Office of Security indices. The best paper tape producing equipment is manufactured by Friden, Incorporated, and is known as flexowriter. The best punch card equipment available today is manufactured by IBM and is known as the typewriter card punch Model 826. The criteria for determining what type of subjects or references should be carded are not material in this situation. What is material is the format and content of the card. In order to determine the relative advantages of the two systems, the following basic comparisons should be considered:

1. Unit Record Length

If the unit record length is above 80 characters, the punched card system will require the use of trailer cards. This is not particularly troublesome if the above 80 character unit records are a relatively minor portion of the total number. However, this becomes a more time consuming operation if there is a substantial number of these trailer cards. Punched paper tape is continuous and allows unit records of indefinite length. It has been determined that the desired unit record length will be less than 80 characters in all but a very small percentage of the cases. See Tab A.

2. Use of the Machine Language By-product

If the data so developed is to be stored and merely "dumped" into a computer eventually, either system could be used. However, if it is desired to utilize the developed data in the

reporting and/or control systems, punch cards would have to be used. In the present study, it has been observed that punch cards could be usefully employed in both the reporting and control systems.

3. Machine Delivery Time

Both flexowriter and IBM typewriter punch card machines require approximately four months delivery time. Flexowriters must be ordered by specific model and include modification specifications. IBM typewriter punch card machines are standardized and, therefore, can be ordered by merely model numbers. Since the Office of Security has an IBM representative assigned to it from the ADP Staff, it was possible to informally back order IBM Model 826 machines in May upon the contingency that these machines may be the ones desired. This means that delivery can be obtained in September 1962.

4. The Method of Computer Storage

The two most logical computer storage methods available are either magnetic tape or random access central storage memory. If magnetic tape is used, it will be necessary to have the accumulated data sorted alphabetically either on EAM equipment (by means of punch cards) or by the use of higher cost (approximately $200 an hour) computer time, since the subsequent searching operations will have to be conducted in an alphabetical serialized fashion. If, however, random access storage is utilized, the information can be inserted in the computer in a random fashion as far as the alphabetical sequence is concerned. The dominating factors in deciding which storage method will be used will be first, the cost of the two methods and, second, the total storage requirements of the complete system. In relatively small storage systems (100,000,000 characters or less) the random access type is more desirable and is not significantly more expensive than the use of magnetic tape. In large storage systems (100,000,000 characters or over) the cost tends to favor the use of magnetic tape with serial access techniques. In addition, the state of the art is now limited to about 200,000,000 characters for a system of random access type storage. Assuming an average unit record length of approximately 60 characters, the present indices system alone would contain 90,000,000 characters which raises the question of the feasibility of a random access system. This is particularly true in view of the other requirement of the Office of Security,

as well as program requirements which will require millions of additional characters. If there is a good chance that serial access may be necessary because of the need for a large number of characters, the punch card system would be favored because the information can be correlated alphabetically through relatively simple EAM methods. If, on the other hand, the system is clearly going into a random access memory, then the difference between punch paper tape or punch cards would be minimal. It is concluded that there is a reasonable possibility that the data may go into magnetic tape storage which will require the serial access method.

5. The Choice and Cost of Computer Equipment

At the present time the Office of Security, as part of DD/S, has available to it the RCA 501/IBM 1401 combination. This system will accept punched paper tape directly into the RCA computer or punched cards into the 1401 peripheral computer. The RCA 501 is presently overloaded with work and the 1401 (which will be installed sometime in late 1962) is now being programmed for certain DD/S applications. At this stage of the DD/S ADP planning, it is impossible to predict (1) the availability of this equipment, or (2) the advisability of having a separate computer for the Office of Security. In any event, however, the final decision as to what computer equipment will be used will have to be made on the basis of the total needs of the Office of Security and the other DD/S elements. Since no firm prediction can be made in this area at this time, this factor will have to be left unresolved.

use of 1401 dropped

6. The Choice and Cost of EAM Equipment

The cost of the actual typing-punch equipment to produce the machine language by-product, is known. It is estimated that it will take three machines in SRD to produce new indices cards now being typed and one machine in the typist pool for the consolidation program. If the machines are purchased, each IBM machine would cost approximately $5,000 plus $200 a year maintenance, and each flexowriter would cost approximately $3,000 plus $200 a year maintenance. On a rental basis the IBM equipment would cost $120 a month in contrast to the flexowriter which would cost approximately $200 a month. Thus, if punch card equipment is desired, rental is indicated. If punch paper tape equipment is desired, purchase is indicated.

7. Verification

At the present time the operators producing the 3 x 5 cards have been using sight verification. With the production of machine language by-product, the possibility of machine verification presents itself. Statistics generated over a long period of time have indicated that normal two person sight verification rarely exceeds 95% accuracy. This means we may expect a 5% or higher typing error in the index cards under the present system. This error rate, of course, can be influenced by the degree of care taken in the sight verification techniques. Many studies have also shown that with machine verification there is significantly less than 1% error. Machine verification would include only the name and file number. This can not be accomplished by the IBM Model 826.

8. The Form of the Printing in the Machine Output

This will vary depending upon the system used. Only all capitals will be available in the punch card system. The flexowriter provides both upper and lower case letters.

9. The Element of Storage of the Cards or Tape

Depending upon the average unit record length of the punch cards, the actual storage volume used by the punch paper tape versus punch cards can be as high as 10 to 1 in favor of the punch paper tape. In any event, however, the total volume involved here is something that can be placed in one part of a small room even if the punch cards were used. This does not appear to be a significant factor since space is available at the Records Center.

10. Typing Error Correction

On a flexowriter this is accomplished by normal back-spacing and cancelling of the letters by depressing the error key. These positions on the tape then represent plain tape feed through code which means in effect nothing to the retyping or transfer to storage operation. An error made on a punch card requires the removal of the punch card from the machine and the retyping of a new punch card. If an error is made near the end of the unit record which is producing a punch card, the operator must retype practically a whole new card. Therefore, in an average unit record length of 60 characters, the average retyping upon making an error is 30 characters.

11. Speed and Accuracy of Typing

This applies equally well to either system since in either case the same standard keyboards are used.

12. Training of Operators

This factor applies equally to either system, but it must be considered in sufficient time to have the operators trained for the equipment to be ordered. The training period for the typical typist is a matter of a few days.

13. Later Conversion and Reformating Techniques

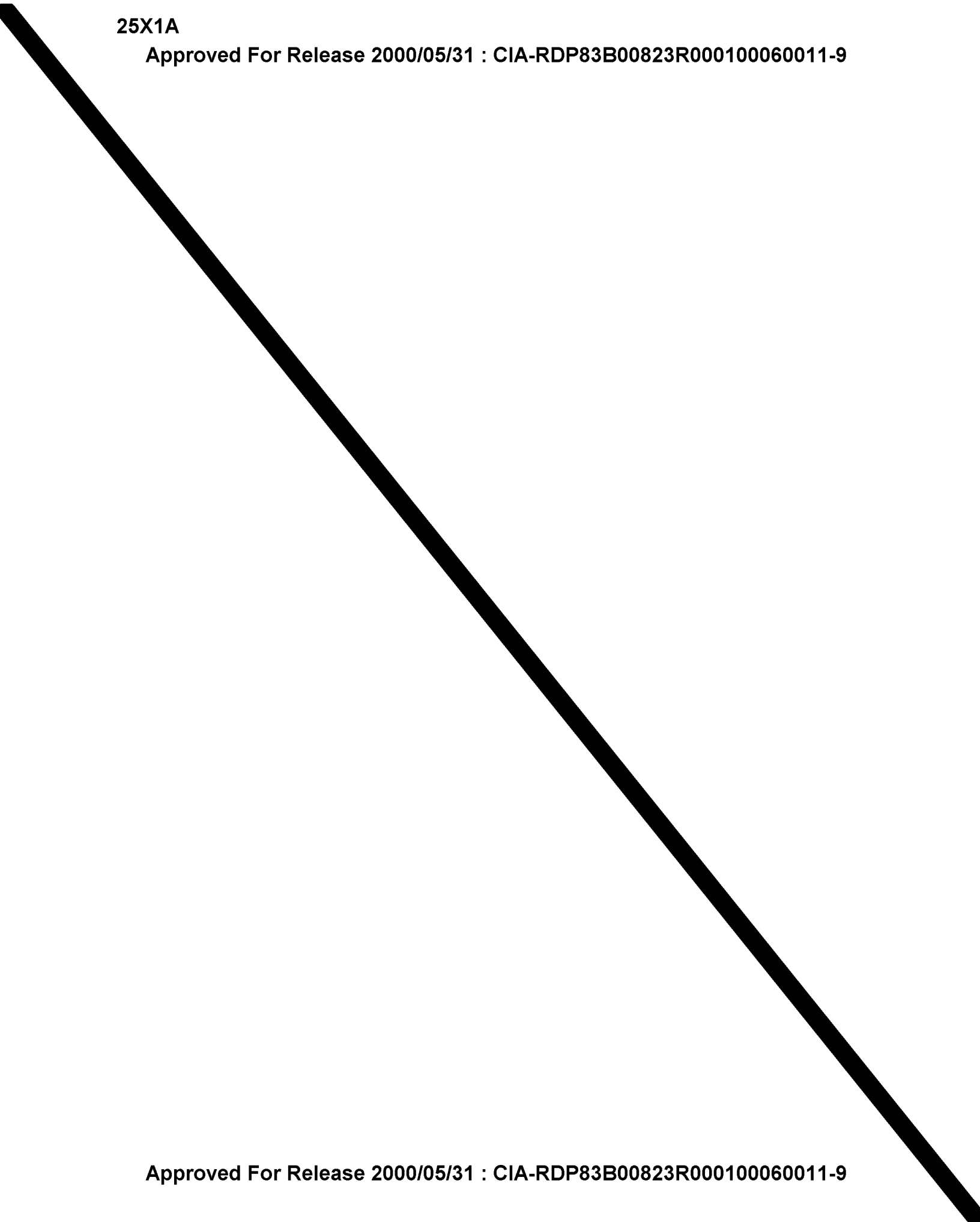
To be able to put the machine data into a computer memory, it will be necessary to provide certain codes and formats before the raw data can be "dumped" into the computer. The method and extent of desired retrievability of the various elements of the unit record will determine the complexity of the programming involved into getting information into the computer. If the program is properly planned, this problem will not affect the favoring of one system over the other.

14. Speed of the Input to the Computer

This is a relatively minor factor. However, the input speed of cards is somewhat higher than that for punch paper tape. This would mean in the initial "dump" as well as subsequent operations, somewhat less computer time will be necessary if punch cards are used.

ILLEGIB

[redacted]



CHRONOLOGICAL LISTING
SOLID-STATE SYSTEMS

Mar — Univac I

Apr — IBM 701

Jul — Burroughs 205
Dec — IBM 650

Feb — IBM 702
Aug — CDC G-15
Dec — IBM 704
? — Alwac IIIE
? — Burroughs E-101

Jan — IBM 705
Mar — Univac 1103A
Sep — RPC LGP 30
Dec — IBM 705, II

Nov — IBM RAMAC 305
Nov — Univac II

Jan — Univac File Computer
Sep — IBM 709
Sep — Univac 1105
Dec — Burroughs 220

Nov — Philco 2000 210
Nov — Recomp II

Jun — IBM 705, III
Nov — NCR 304
Nov — RCA 501

Jan — Control Data 1604
Jan — General Precision L-3000
Jan — Univac SS 80/90
Mar — Philco 2000 211
May — Monrobot XI
May — Univac Larc
Jun — IBM 7070
Jun — IBM 7090
Jul — Control Data 160
Sep — IBM 1401
Oct — IBM 1620
Nov — DEC PDP-1
Nov — General Electric 210
Nov — RPC-4000
Dec — Honeywell 800
Dec — Packard Bell 250

Jan — General Electric 225
Feb — RCA 301
Apr — CDC G-20
Apr — NCR 310
May — Computer Control DDP-19
May — IBM 7030 Stretch
May — NCR 390
Jun — Recomp III
Jul — CDC 160A
Aug — CDC 924
Sep — Burroughs B250
Sep — IBM 7080
Nov — IBM 1410
Dec — Honeywell 400
Dec — IBM 7074
Dec — Univac 490

Jan — NCR 315
Jan — Univac File Computer II
Mar — IBM RAMAC 305 II
Apr — ASI 210
Jun — IBM 7072
Jun — Univac III
Jul — Burroughs B260-270-280
Jul — DEC PDP-4
Aug — SDS 910
Sep — IBM 7094-I
Sep — SDS 920
Sep — Univac 1107
Nov — RCA 601

Jan — ASI 420
Feb — Burroughs B5000
Feb — H-W 15K
Feb — Philco 2000 212
Mar — General Precision LGP-21
Apr — CDC 3600
Apr — IBM 7040
Jun — Computer Control DDP-24
Jun — Philco 1000
Jun — Thompson Ramo Wooldridge 230
Jul — IBM 7044
Sep — Packard Bell 440
Sep — Univac 1004
Sep — Univac 1050
Oct — DEC PDP-5
Oct — IBM 1460
Nov — Honeywell 1800
Nov — IBM 1440
Dec — ASI 2100
Dec — Honeywell 1400
Dec — SDS 9300
? — Hughes Aircraft H-330
? — RCA 601
? — General Electric 215

Jan — IBM 7010
Apr — IBM 7094 II
Jun — CDC 6600
Jul — DEC PDP-6
Nov — National 315-100
? — RCA 3301

*Many computers delivered in 1953 through 1958 but no longer being produced have not been included in this list. The IBM 701 and 702 are not in the chart but appear here as landmarks.

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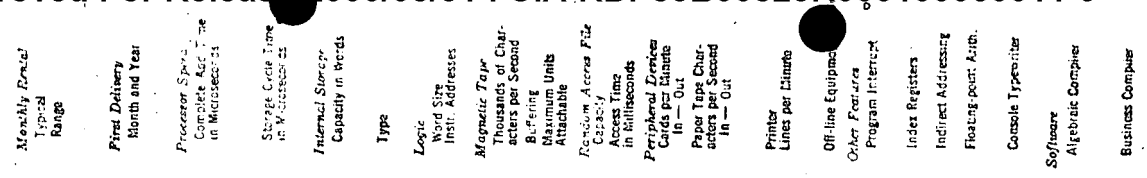

EXPLANATION OF COLUMN HEADINGS

Monthly Rental

Typical — The purchase price usually is equal to from forty to fifty times the monthly rental, though in the case of manufacturers who prefer to sell their equipment or lease it through an agency, the fraction is as low as thirty. (Monthly rental information appears only in Sections I, IV and V.)

Range — What a customer might pay for a system with basic peripheral equipment and, if available, magnetic tapes.

Range — The first figure in parentheses is the cost, in thousands of dollars, of the minimum useful configuration. The second figure, where given, is the approximate cost of the maximum configuration likely to be ordered.

First Delivery

Month and Year — The date on which the first operating installation was or will be made.

Processor Speed — The effective speed of the central processor is measured roughly by some hard-to-determine average of the add time and cycle time, lightly salted with the number of instruction addresses. In addition, such features as instruction look-ahead, overlapped core memory banks, asynchronous memory and others referred to in the computer footnotes influence the over-all computing speed of a system.

Complete Add Time in Microseconds — The time required to acquire and execute one fixed-point add instruction. Where add time is faster than or equal to cycle time in other than core memory machines, maximum optimization has been assumed.

Storage Cycle Time in Microseconds — For core storage, the total time to read and restore; for drum or other serial storage, the total time for one full revolution.

Internal Storage — The internal storage capacity is measured by multiplying the number of words by the word length, throwing in an extra factor of three to four if the words are decimal or four to six if they are alphabetic.

Capacity in Words — The number of words of addressable internal storage available or the number of characters in character-addressable systems where the word size is shown as 1. In both, K represents thousands.

Type — The type of memory, namely, core, drum or fast (the last indicating a serial type area of fast access secondary storage). For example, "32K core" means that 32,000 words of magnetic core are available.

Logic — Each computer has its own instruction code and other logical specifications which affect the speed and ease of programming. Any unusual instruction code features are mentioned in the computer footnotes. The "Other Features" columns also contain some information which gives further insight into logic.

Word Size — The number and type of digits comprising one storage word (a = alphanumeric, six, seven or eight binary digits, depending on parity and addressing logic; d = decimal, four binary digits; b = binary, one binary digit).

Instr. Addresses — The number of separate storage addresses in a conventional instruction.

Magnetic Tape — Tape file effectiveness is measured by characters per second but with a number of qualifications, including buffering.

Thousands of Characters per Second — The transfer rate between the computer and magnetic tape, measured in six-bit characters (one alphabetic, one decimal, or six binary digits) unless otherwise noted.

Buffering — The letters in parentheses indicate that combinations of reading magnetic tape (R), writing it (W), and computing (C) can be performed simultaneously. (M) indicates that multiple simultaneous operations are possible.

Maximum Units Attachable — The largest number of units which can be attached to and addressed by the computer.

Random Access File — In most instances this is considered as auxiliary storage which is addressable by groups of words rather than by individual words.

Capacity — The maximum number of characters available (M representing millions) in an external mass storage unit such as tape loop, drum or disc. The type of characters and the characteristics of the storage unit are shown in the computer footnotes. Where the units attachable are virtually unlimited, the numbers shown are for one unit; otherwise they are for the total of all units which can be attached.

Access Time in Milliseconds — The time required to locate a single record, including read-write head positioning and normal rotational access time (i. e., half the revolution time for drum and disc storage).

Peripheral Devices — If other standard input-output devices are available in addition to cards, paper tape and printers, they are referred to in the computer footnotes.

Cards per Minute In - Out — The maximum number of cards which can be read or punched on-line by the computer in the time stated.

Paper Tape Characters per Second In - Out — The maximum number of characters which can be read or punched on-line by the computer in the time stated.

Printer Lines per Minute — The maximum number of lines which can be printed by the computer in the time stated. Unless otherwise specified in the computer footnotes, each line is considered to be 120 columns wide.

Off-line Equipment — Reference is made, by name or model number, to a smaller satellite computer which can be used to prepare input to or process output from the main system. "Same" means that on-line peripheral equipment can be disconnected from and used independently of the central computer.

Other Features

Program Interrupt — A check (√) indicates the availability of a special feature which, on the occurrence or completion of an external operation, causes a new program sequence to be initiated.

Index Registers — The number represents the maximum special registers whose contents may be added to the address portion of an instruction to form an effective instruction address.

Indirect Addressing — A check (√) indicates the availability of a special feature which permits the use of the specified address as the effective address for an instruction.

Floating-point Arith. — This can be programmed in any system, of course, even though not a built-in feature. However, only where floating-point arithmetic is integral to the machine is this capability indicated by a check (√).

Console Typewriter — O refers to a device capable of printing alphanumeric characters at the console; I/O refers to a console keyboard capable of supplying data to the computer and actuating the printer.

Software — Software comprises standard programs used to compile symbolic programs from statements in a problem-oriented language, assemble machine-language from symbolic programs, and aid in the operation and testing of programs written by the ultimate users of the computers. The best known are the compilers, especially those which accept procedural statements expressed in COBOL, ALGOL or FORTRAN source language. This information appears only in Sections I, IV and V.

Algebraic Compiler — The month and/or the year in which such a compiler became or will be available is shown in the computer data and the name of the compiler indicated in the footnotes.

Business Compiler — The information is presented in the same format as that for algebraic compilers.

	Monthly Rental Typical Range	First Delivery Month and Year	Processor Speed Complete Add Time in Microseconds	Storage Cycle Time in Microseconds	Internal Storage Capacity in Words	Type	Logic Word Size Instr. Addresses	Magnetic Tape Thousands of Characters per Second Reading	Maximum Units Attachable	Rotational Access File Capacity	Access Time in Milliseconds	Peripheral Devices Cards per Minute In — Out	Paper Tape Characters per Second In — Out	Printer Lines per Minute	Off-line Equipment	Other Features Program Interrupt	Index Registers	Indirect Addressing	Floating-point Arith.	Console Typewriter	Software Algebraic Compiler	Business Compiler
IBM 7030 STRETCH	$160,000[A]	5/61	1.5[C]	2.2	16-262K core	64b 1	62 256 MRWC[J]	71.4M 132[M]	1000 250	—	600	1401	√	16	√	√	I/O	—	—
A. Computer no longer marketed. C. Instruction look-ahead and overlapped core banks allow increased internal speed. J. Input-output under separate control. M. Access time varies from 51 to 231 milliseconds, depending on file organization.																						
UNIVAC LARC	$135,000[A] (135-)	5/60	4[C]	4	10-97K core	12d 1	25 40 MRWC[J]	36M[L] 68	N	P	Q	R	—	99	√	√	I/O	—	—
A. Computer no longer marketed. C. Instruction look-ahead and overlapped core banks allow increased internal speed. J. Input-output under control of a separate computer and it is possible to add a second computing unit. L. Up to 24 drums of 250,000 words each. N, P, Q, R. All UNIVAC peripheral equipment (including high-speed film printer) can be used.																						
CONTROL DATA 6600	$120,000	6/64	.7	.7	16-262K core	60b 1	30-83 MRWC	— —			1000 250	350 110	1000	—	√	√	√	√	--	—	—	—
Note. Preliminary information not confirmed by manufacturer. System has not been formally announced by CDC.																						
IBM 7094 MODEL II	$76,000 (72-131)	4/64	1.4 2.8[C]	1.4 17500	32K core 186K drum	36b 1	15-170[H] 80 MRWC[J]	220M[L] 160			250 100	— —	150	1401 1460	√	7	√	√	-	6/63[X]	6/63[Y]	
C. Instruction look ahead and interleaved core memory banks allow increased internal speed. H. See information on tape speeds (IBM 7090 and 7080). J. Data channels (up to eight) are separate input-output controls for up to ten tape units or peripheral equipments. L. IBM 1301 disc file has 56 million BCD characters per unit (up to five units). X. FORTRAN. Y. COBOL, COMmercial TRANslator.																						
IBM 7094 MODEL I	$70,000 (66-106)	9/62	4[C]	2 17500	32K core 186K drum	36b 1	15-170[H] 80 MRWC[J]	220M[L] 160			250 100	— —	150[Q]	1401 1460	√	7	√	√[V]	--	9/62[X]	12/62[Y]	
C. Instruction look-ahead allows increased internal speed. H. See information on tape speeds (IBM 7090 and IBM 7080). J. Data channels (up to eight) are separate input-output controls for up to ten tape units or peripheral equipments. L. IBM 1301 disc file has 56 million BCD characters per unit (up to five units). Q. Off-line printing of 600 or 1100 lpm per printing unit available. V. Double-precision floating point available. X. FORTRAN. Y. COBOL, COMmercial TRANslator.																						
IBM 7090	$63,000 (60-100)	6/60	4.4	2.2 17500	32K core 186K drum	36b 1	15-170[H] 80 MRWC[J]	220M[L] 160			250 100	— —	150[Q]	1401 1460	√	3	√	√	--	/59[X]	12/62[Y]	
H. For all 7000 series, 729 II tape units operate at 15K and 41.6K while 729 IV tape units operate at 22.5K and 62.5K. 729 V and 729 VI tape units (with 800 characters per inch density) operate at 60K and 90K, respectively. (See IBM 7080.) J. Data channels (up to eight) are separate input-output controls for up to ten tape units. L. IBM 1301 disc file has 56 million BCD characters per unit (up to five storage units). Q. Off-line printing 600 or 1100 lpm per unit. X. FORTRAN. Y. COBOL '61, COMmercial TRANslator (9/61).																						
IBM 7080	$55,000 (40-73)	9/61	11[C]	2 1	80-160K core 1K core	1a 1	15-170[H] 40 MRWC	28.8M[L] 160			250 100	500 --	—[Q]	1401 1460	√	0	√	—	I/O	8/61[X]	12/61[Y]	
C. Add time assumes a five-character field. H. The IBM 7340 (1963 delivery) Hypertape Drive, with cartridge load, will read in both directions or write 170,000 alphabetic (or 340,000 numeric) characters per second. (For 729 tape speeds, see IBM 7090.) L. IBM 1301 disc file. Q. Off-line printing 600 or 1100 lpm per unit. X. FORTRAN. Y. COBOL '61.																						
CONTROL DATA 3600	$55,000 (40-75)	4/63	2[C]	1.5	32-262K core	48b 1[G]	30-83[H] 4096[K] MRWC[J]	720M 100			1000 250	350 110	1000	160A	√	6	√	√[V]	I	4/63[X]	4/63[Y]	
C. Overlapped core banks allow increased internal speed. G. Instructions stored two per word. H. CDC Model 606 or IBM 729 tape units. J. Data channels (up to eight) are separate input-output controls for tape units and other peripheral equipment. K. Magnetic tapes are IBM compatible. V. Double-precision floating point available. X. FORTRAN. Y. COBOL.																						
HUGHES AIRCRAFT H-330	$53,000 (35-)	/63	1.8[C]	1.8	16-131K core	48b[F] 1	30-83 128 MRWC	-- —			1500 300	350 110	1000	same	√[H]	24[T]	√	√	I/O	/63[X]	—	
C. Instruction look-ahead and overlapped core banks allow increased internal speed. F. Word size is optional; may be 24b, 30b, 36b or 48b. S. Forty-nine levels of program interrupt available. T. Also 24 decrement registers. X. FORTRAN IV. Note. Preliminary information not verified by publisher.																						
GENERAL PRECISION LGP-30	$50,000 (25-)	1/60	16[C]	5	4-64K core	8a 1[G]	50 1023 MRWC	200M 90			200 100	350 60	1000	same	√	√	11	√	√	I/O	—	—
C. Full cycle time; instruction look-ahead and overlapped core banks allow increased internal speed. G. Variable field addressing allows designation of operands from one to eight characters.																						
PHILCO 2000 Model 212	$50,000 (35-80)	2/63	.6[C]	1.5	32-65K core	48b 1[G]	80-240 MRWC[J]	64[K] 167M[L] 135			2000 100	1000 60	900	1000 same	√	8	√	√[V]	I/O	/59[X]	/62[Y]	
C. Instruction look-ahead (four-level) and asynchronous, overlapped core banks allow increased internal speed. G. Instructions stored two per word. J. Two separate input-output processors, each of which controls up to 32 tape units. K. Magnetic tapes read in forward and reverse directions. L. Up to four disc file units of 5,242,880 words each (41,943,000 characters per disc) are available. V. Double-precision floating point available. X. ALTAC, Fortran type. Y. COBOL '61.																						
UNIVAC 1107	$45,000 (32-60)	9/62	4[C]	4 .6	16-65K core 128 film	36b[F] 1[G]	25-120 MRWC	160[K] 66M[L] 300[N]			600 110	400	600 700	SS80/90 1050	√	15	√	√	I/O	10/62[X]	12/62[Y]	
C. Overlapped core banks and thin film memory usage allow increased internal speed. F. A half, third or sixth word may be addressed directly. G. Designators in each instruction permit use of virtual two- or three-address instruction logic. K. Magnetic tapes read in forward and reverse directions. An IBM compatible type unit is available. L. Each flying head drum unit (eight per subsystem with maximum of 15 subsystems) has a capacity of 786,432 words or 4,518,592 BCD characters. Each FASTRAND drum unit (eight per subsystem with maximum of 15 subsystems) has a capacity of 66.06 million alphanumeric characters. N. 150 cpm punch available. X. ALGOL, FORTRAN. Y. COBOL '61.																						

	Monthly Rental Typical Range	First Delivery Month and Year	Processor Speed Complete Add Time in Microseconds	Storage Cycle Time in Microseconds	Internal Storage Capacity in Words	Type	Logic Word Size Instr. Addresses	Magnetic Tape Thousands of Characters per Second Buffering Maximum Units Attachable	Random Access File Capacity Access Time in Milliseconds	Peripheral Devices Cards per Minute In—Out	Paper Tape Characters per Second In—Out	Printer Lines per Minute	Off-line Equipment Other Features Program Interrupt	Index Registers	Indirect Addressing	Floating-point Arith.	Console Typewriter	Software Algebraic Compiler	Business Compiler
PHILCO 2000 Model 211	$35,000 (24-66)	3/60	6.2[C] 9	10	8-32K core	48b 1[G]	90 MRWC	16[K]	262K[L] 17	2000 100	1000 60	900	1000 same	√	8	—	√	I/O	/59[X] /62[Y]
C. Asynchronous, overlapped core banks allow increased internal speed. G. Instructions stored two per word. K. Magnetic tapes read in forward and reverse directions. L. Additional drums of 32,768 words (262,144 characters) each are available. X. ALTAC, Fortran type. Y. COBOL '61.																			
HONEYWELL 1000	$35,000 (27-60)	11/63	8[C]	2	8-32K core	12d[F] 3	89-124[H] MRWC	64[K]	720M[L] 100	800[N] 250[N]	1000[P] 110	150 900	same	√	64[T]	√	√	I/O	/61[X] /61[Y]
C. Complete time for normal three operand addition. F. Word size is 12d including sign or 48b with binary and decimal arithmetic instructions included. H. Numeric information can be transferred at 133,000 or 186,000 ch/sec. K. Magnetic tapes read in forward and reverse directions with programmed error correction (Orthotronic count). L. Units of 12 Bryant discs contain 45 million BCD characters with increments of 24 discs up to a maximum of 96 discs. N. 240 and 650 cpm readers and 100 cpm punch available. P. 200 ch/sec reader available. T. Up to eight programs can be processed concurrently. X. AUTOMATH 1800 (/63), Fortran type. Y. FACT, COBOL '61 (/63).																			
CONTROL DATA 1604	$34,000 (19-35)	1/60	4.8[C]	6.4	8-32K core	48b 1[G]	30-83[H] MRWC	96[K]	— —	1300[N] 100	350 110	150 1000	160A	√	6	√	√	I/O	/60[X] 2/62[Y]
C. Overlapped core banks allow increased speed. G. Instructions stored two per word. H. CDC Model 606 tape unit operates at 30K (with 200 characters per inch density) or 83K (with 556 characters per inch density), while IBM tape units operate up to 62.5K. K. Compatible with IBM tape units. N. 100 and 250 cpm readers available. X. FORTRAN. Y. COBOL '61.																			
RCA 601	$32,000 (24-68)	11/62	5.7 6.7[C]	1.5[D] 2.5	8-32K core	56b[F] 1-3[G]	33-120[H] MRWC	48	— —	600 200	1000 300[P]	1000	301[D]	√	8[T]	√	√	I/O	/62[X] 9/62[Y]
C. Asynchronous, overlapped core banks allow increased internal speed. D. 604 central processor has faster staticizing and address modification than 603. F. Binary and decimal arithmetic instructions included. G. Variable length instructions (one, two, three or four half words) operate on character, half-word or word. H. Numeric information can be transferred at a rate of 180,000 ch/sec. P. 100 ch/sec punch available. T. Eight index registers available for each program. X. ALGOL. Y. COBOL '61.																			
IBM 7074	$29,300 (17-36)	12/61	10[C]	4	5-30K core	10d[F] 1	15-170[H] RWC[J]	40	280M[L] 160	500 250	— —	150[Q]	1401 1460	√	99	√[U]	√	I/O	/61[X] 2/62[Y]
C. Parallel adder circuit increases speed over serial circuit in IBM 7070. F. Word size is 10d plus sign. H. See IBM 7090 and IBM 7080 for 729 and 7340 tape data. J. MRWC possible when four channels are used. L. IBM 1301 disc file. Q. Off-line printing 600 or 1100 lpm per unit. U. Indirect addressing limited to scatter-read and gather-write operations. X. FORTRAN. Y. COBOL '61.																			
PHILCO 2000 Model 210	$28,000 (20-60)	11/58	15[C]	10	8-32K core	48b 1[G]	90 MRWC	16[K]	262K[L] 17	2000 100	1000 60	900	1000 same	√	8	—	√	I/O	/59[X] 12/62[Y]
C. Asynchronous overlapped core banks allow increased internal speed. G. Instructions stored two per word. K. Magnetic tapes read in forward and reverse directions. L. Additional drums, each having a capacity of 32,768 words (262,144 characters), are available. X. ALTAC, Fortran type. Y. COBOL '61.																			
IBM 7044	$26,000 (20-55)	7/63	5	2.5	8-32K core	36b 1	7.2-90[H] MRWC[J]	50	280M 160	250[N] 125	500 —	600 1100[Q]	1401 1460	√	3	√	√	I/O	9/63[X] 10/63[Y]
H. For tape information see IBM 7090. J. 7904 data channels available for separate input-output control of up to ten peripheral units. N. IBM 1401 can be connected on-line through input-output synchronizers or 800 cpm reader, and 250 cpm punch and/or printer can be connected to the input-output channel through 1414 synchronizer. Q. Up to total of 3300 lpm available. X. FORTRAN. Y. COBOL.																			
UNIVAC 490	$25,500 (18-)	12/61	4.8[C] 12	6	16-32K core	30b 1[G]	25-125[H] MRWC	192[K]	377M[L] 17	600 150	400 110	600 700	SS80/90 1060	√	7	—	—	I/O	/61[X] 10/62[Y]
C. This is add time for repeat mode only. G. Half-word logical operations can be performed. H. Numeric information can be transferred at a rate of 175,000 ch/sec. K. Magnetic tapes read in forward and reverse directions. IBM compatible tape units available. L. Each flying head drum unit (eight per subsystem with maximum of 12 subsystems) has a capacity of 786,432 words or 3,932,160 BCD characters. Each FASTRAND drum unit (eight per subsystem with maximum of 12 subsystems) has a capacity of 64.8 million alphanumeric characters. X. NELIAC. Y. COBOL '61.																			
IBM 7070	$24,000 (12-31)	6/60	60[C]	6	5-10K core[E]	10d[F] 1	15-90 RWC[J]	40	280M[L] 160	500 250	— —	150[Q]	1401 1460	√	99	√[U]	√	I/O	/60[X] 2/62[Y]
C. Add time varies by number of digits in field to be added and does not include indexing time. E. Up to 30K core memory available. F. Word size is 10d plus sign. J. MRWC possible when four channels used. L. IBM 1301 disc file has 28 million six-bit characters per 25-disc module or 43 million four-bit characters stored in packed (eight-bit) format. Model II 1301 has two modules or 50 discs. Q. Off-line printing 600 or 1100 lpm per unit. U. Indirect addressing limited to scatter-read and gather-write operations. X. FORTRAN. Y. COBOL '61.																			
UNIVAC III	$22,500 (16.6-30)	6/62	8	4	8-32K core	6d[F] 1[G]	25-133[H] MRWC	38[K]	√[L] —	700 300	500[P] 110	700[Q]	SS80/90 1050	√	15	√	—	I/O	12/62[X] 10/62[Y]
F. Word size is 6d plus sign. G. Instruction may process up to four data words. H. Numeric information can be transferred at a rate of 200,000 ch/sec. Model IIA tape units operate at 25K while Model IIIA units function at speeds of 120K to 133K, depending on internal logic variations of UNIVAC 1107, 490 and III. K. Magnetic tapes read in forward and reverse directions. IBM compatible tape units available. L. Specifications unavailable. P. 1500 ch/sec possible in non-stop mode. Q. Numeric information only printed at 922 lpm. X. FORTRAN. Y. COBOL '61.																			
HONEYWELL 800	$22,000 (19-35)	12/60	24[C]	6	4-32K core	12d[F] 3	64-124[H] MRWC	64[K]	720M[L] 100	800[N] 250[N]	1000[P] 110	150 900	same	√	64[T]	√	√	I/O	/61[X] /61[Y]
C. Complete time for normal three operand addition. F. Word size is 12d including sign or 48b with binary and decimal arithmetic instructions included. H. Numeric information can be transferred at 96,000, 133,000 or 186,000 ch/sec. K. Magnetic tapes read in forward and reverse directions with programmed error correction (Orthotronic count). L. Units of 12 Bryant discs contain 45 million BCD characters with increments of 24 discs up to a maximum of 96 discs. N. 240 and 650 cpm readers and 100 cpm punch available. P. 200 ch/sec reader available. T. Up to eight programs can be processed concurrently. X. AUTOMATH 800, Fortran type. Y. FACT, COBOL '61 (/63).																			

	Monthly Rental Typical Range	First Delivery Month and Year	Processor Speed Complete Add Time in Microseconds	Storage Cycle Time in Microseconds	Internal Storage Capacity in Words	Type	Logic Word Size Instr. Addresses	Magnetic Tape Thousands of Characters per Second Buffering Maximum Units Attachable	Random Access File Capacity Access Time in Milliseconds	Peripheral Devices Cards per Minute In — Out	Paper Tape Characters per Second In — Out	Printer Lines per Minute	Off-line Equipment	Other Features Program Interrupt	Index Registers	Indirect Addressing	Floating-point Arith.	Console Typewriter	Software Algebraic Compiler	Business Compiler
RCA 3301	$21,000 (14-40)	/64	32[C]	1.75 .25	40-160K core 200 fast[E]		1a 2	30-120[K] 24 RWC	528M[L] 100	900[N] 300	1000 100	1000	—	√	3	√	√	I/O	/64[X]	/64[Y]
CONTROL DATA 6-20	$20,000 (7.3-35)	4/61	15[C]	6	4-32K core		32b 1[G]	120[H] 500 MRWC	62M[L] 90	800 250	500 100	1000 300	same	√	63	√	√	I/O	2/62[X]	12/62[Y]
IBM 7010	$18,500 (12-35)	1/64	33[C]	2.4	40-100K core		1a[F] 2	7.2-90[H] 20 MRCW	280M[L] 160	800 250	500 —	600[Q] 1100	1401 1460	√	15	—	√	I/O	12/61[X]	6/62[Y]
BURROUGHS B5000	$16,200 (13.5-50)	2/63	3[C]	6 17000	4-32K core 32K drum[E]		48b 0[G]	24-66 16[K] MRWC	960M[L] 20	800[N] 300	1000 100	700	B280	√	—[T]	√[U]	√[V]	I/O	/62[X]	/62[Y]
RCA 501	$16,000 (11-26)	11/59	360[C]	15 12[D]	16-262K core		1a[F] 2	33-66 63[K] RC, WC, or RW	— —	600 200	1000 100[P]	600 900	301[R]	—	8	√[U]	—	O	—	/60[Y]
IBM 7072	$15,800 (14-32)	6/62	12	6	5-30K core		10d[F] 1	7.2-20[H] 20[K] RWC	— —	60 —	— —	— —	1401 1460	√	99	√[U]	√	I/O	/60[X]	12/62[Y]
NATIONAL 304	$15,000 (12.5-19)	11/59	600 120[C]	60	2-4K core		10a 3[G]	30 64[K] RW[J]	— —	2000 250[N]	1800 60	680 900	same	—	10	—	√	I/O	—	8/61[Y]
GENERAL ELECTRIC 210	$14,000 (10.5-36)	11/60	64	32	4-8K core		6d[F] 1[G]	30 13 RWC	— —	1500[N] 250[N]	200 —	1000[Q]	—	—	1	—	—	I/O	—	/61[Y]
IBM 7030	$14,000[A] (9-36)	4/63.	16	8	4-32K core		36b 1	7.2-90[H] 50 MRWC[J]	280M 160	250 125	500 —	600 1100[Q]	1401 1460	√	3	√	√	I/O	9/63[X]	10/63[Y]
IBM 1410	$13,500 (6-32)	11/61	88[C]	4.5	10-80K core		1a[F] 2	7.2-90[H] 20 RWC	280M[L] 160	800[N] 250	500 —	600 1100[Q]	1401 1460	√	15	—	—	I/O	12/61[X]	12/61[Y]
HONEYWELL 1400	$14,000 (10-22)	12/63	78[C]	6.5[D]	4-16K core		12d[F] 3	32-89[H] 16 RW	100M[L] 110	800[N] 250	1000 110	900	same	√	3	—	√	I/O	/63[X]	/63[Y]
GENERAL ELECTRIC 235	$10,900 (3-26)		12	6	4-16K core		20b 1[G]	15-41 56 MRWC	526M[L] 199	1500[N] 300	1000[P] 110	900	same	√	93[T]	—	√	I/O	1/62[X]	1/62[Y]
CONTROL DATA 1604	$10,000 (8.7-20)	8/61	9.3[C]	6.4	8-32K core		24b 1	15-83[H] 96[K] MRWC	— —	1300[N] 100	350 110	150 1000	160A	√	6	√	—	I/O	—	—

C. Add time assumes a five-character field. E. 50 four-character words of micro-ferrite construction. K. Magnetic tapes read in forward and reverse directions. L. Up to eight disc five units, each of four modules of 22, 44, 66 or 88 million alphanumeric characters, are available. N. 1470 cpm possible when reading 51 columns.

C. All arithmetic operations done in floating-point mode. G. Variable instruction length permits multiple operations. H. Numeric information can be transferred at 240,000 ch/sec. Independent search while computing. L. Bryant disc has capacity of 15.6, 31.2, 48.6 or 62.4 million eight-bit characters. X. ALCOM 2/62, FORTRAN 5/62. Y. COBOL '61.

C. Add time assumes a five-character field. F. Variable-length instructions operate on variable-length data fields. H. For tape information see IBM 7090. L. Up to five IBM 1301 disc units available with 28 or 56 million alphanumeric characters each. Up to ten 1311 disc storage drives each with a capacity of three million characters are also available. Q. Numeric information only printed at 1285 lpm. X. FORTRAN. Y. COBOL.

C. Instruction look-ahead allows increased internal speed. E. Two drums available. G. Polish notation allows operations to be performed without designation of addresses. K. Magnetic tapes read in forward and reverse directions. L. Each B472 Storage Unit has a capacity of 48 million characters, in modules of 9.6 million characters. Up to 20 units may be attached. N. 200 cpm reader and 100 cpm punch available. T. U. All addressing relative to Program Reference Table. V. Double-precision floating point available. X. ALGOL. Y. COBOL '61.

C. Add time assumes a five-character field. D. With new speed-pak feature. F. Variable-word length computer using four-character (tetrad) parallel transfer. K. Magnetic tapes read in forward and reverse directions. P. 300 ch/sec punch available. R. Card equipment and printer may be used off-line. U. Indirect addressing limited to scatter-read and gather-write operations. Y. COBOL '60.

F. Word size is 10d plus sign. H. Low-speed magnetic tape only. K. IBM 7330 tape units. U. Indirect addressing limited to scatter-read and gather-write operations. X. FORTRAN. Y. COBOL '61.

C. Micro-flow, single-address instructions. G. Two words per instruction. J. In processing inactive records, RWC is achieved. K. Magnetic tapes have no space between records. N. 100 cpm punch available. Y. COBOL '61.

F. Word size is 6d plus sign. G. Double-precision arithmetic instructions included. N. 400 cpm reader and 100 cpm punch available. Two 1200 MICR-document per minute sorter-readers can be multiplexed. Q. Printer can print magnetically-encoded characters and also be used off-line. Y. CAP.

A. Identical to IBM 7044 with exception of internal operating speeds. H. For tape information see IBM 7090. J. 7094 data channels available for separate input-output control of up to ten peripheral units. Q. Up to total of 3300 lpm printing available. X. FORTRAN. Y. COBOL.

C. Add time assumes a five-character field. F. Variable-length instructions operate on variable-length data fields. H. For tape information see IBM 7090. L. Up to five IBM 1301 disc units available with 28 or 56 million alphanumeric characters each. Up to ten 1311 disc storage drives, each with a capacity of three million characters also available. N. MICR reader available. Q. Numeric information only printed at 1285 lpm. X. FORTRAN. Y. COBOL '61.

C. Complete time for normal three operand addition. D. Cycle time based on 24 bits (4 characters). F. Word size is 12d plus sign or 48b. H. Numeric information can be transferred at rate of 48,000, 96,000 or 133,000 ch/sec. L. Bryant discs in increments of 25 million BCD characters. N. 650 cpm reader and 100 cpm punch available. X. AUTOMATH, Fortran type. Y. COBOL '61.

G. Binary, decimal, and double-precision arithmetic instructions included. L. Up to 28 Data Products units of 16 discs each available. Each module capacity is 18.8 million characters. N. 400 cpm reader and 100 cpm punch available. Two 1200 MICR document-per-minute sorter-readers available. P. 250 ch/sec reader available. T. Three index registers standard. Additional 93 available as option. X. ALGOL functions as a part of GECOM. WIZ. FORTRAN. Y. COBOL '61 as part of GECOM.

C. Overlapped core memory banks allow increased internal speed. H. CDC Model 606 tape unit or IBM 729 tape units. For tape information see CDC 1604. K. Magnetic tapes compatible with IBM tape units. N. 100 and 250 cpm readers available.

	Monthly Rental Typical Range	First Delivery Month and Year	Processor Speed Complete Add Time in Microseconds	Storage Cycle Time in Microseconds	Internal Storage Capacity in Characters	Type	Logic Word Size Instr. Addresses	Magnetic Tape Thousands of Characters per Second Buffering Maximum Number Attachable	Random Access File Capacity Access Time in Milliseconds	Peripheral Devices Cards per Minute In — Out	Paper Tape Characters per Second In — Out	Printer Lines per Minute	On-line Equipment	Other Features Program Interrupt	Index Registers	Indirect Addressing	Floating-point Arith.	Console Typewriter	Software Algebraic Compiler	Business Compiler
HONEYWELL 400	$9,000 (6-14)	12/61	111[C]	9.25[D]	1-4K core	12d[F] 3	32-89[H] RW	8	400M[L] 110	800[N] 250	1000 110	900	same	√	3	—	—	I/O	3/63[X]	3/63[Y]
C. Complete time for normal three operand addition. D. Cycle time based on 24 bits (4 characters). F. Word size is 12d including sign or 48b. H. Numeric information can be transferred at rate of 48,000, 96,000 or 133,000 ch/sec. L. Bryant discs in increments of 25 million BCD characters. N. 650 cpm reader available. X. AUTOMATH 400, Fortran type. Y. COBOL '61.																				
SCIENTIFIC DATA SDS 9300	$9,000 (6.6-15)	12/63	1.75 8300	1.75[C]	4-32K core 16-96K drum	24b 1	16-83[H] MRWC	64	— —	800[N] 250	300 60	1000[Q]	910	√	3	√	√	I/O	3/64[X]	—
C. Overlapped core memory banks allow increased internal speed. H. Magnetic tapes are IBM compatible. N. 100 cpm reader and 100 cpm punch available. Q. 300 lpm printer available. Graph plotters and analog conversion equipment available. X. FORTRAN II.																				
NATIONAL 315	$8,500 (3.8-30)	1/62	48[C]	6	2-40K core	2a[F] 1	24-60 RWC	16	88M[L] 235	2000[N] 250	1000 110	680[Q] 900	—	√	32	—	—	I/O	8/63[X]	10/62[Y] 5/63[Y]
C. Add time assumes a five- or six-character field. F. Decimal format allows 3d word size. L. Magnetically-encoded cards on a drum (CRAM) permit random and sequential file processing. Sixteen units with 5.5 million alphanumeric or 8.3 million BCD characters each. N. MICR documents can be read at 750 per minute. Up to four similar peripheral devices may be attached to each peripheral I/O channel. Q. Numeric information only printed at 1750 lpm. X. FORTRAN II. Y. COBOL '61, 10/62 tape, 5/63 CRAM.																				
IBM 1460	$8,100[A] (3.5-16)	10/63	108[C]	6	8-16K core	1a[F] 2	7.2-90 RC or WC	6	15M[L] 150	800[N] 250	500 150	1100[Q]	—	—	3	—	—	I/O	12/61[X]	6/62[Y]
A. Typical rental for tape system. C. Add time assumes a five-character field. F. Variable-length instructions operate on variable-length data fields. L. IBM 1311 disc drives, featuring interchangeable disc packs, of three million characters each. N. Optical and MICR readers available. Q. 600 lpm printer also available. X. FORTRAN. Y. COBOL '61.																				
DIGITAL EQUIPMENT PDP-9	$8,000 (7.5-19)	7/64	3.5[C]	4 .5	16-262K core 16 fast[E] 96K drum	36b 1	15-90 MRWC	128[K] —	— —	800[N] 300	400 63	1000[Q]	—	√	15	√	√	I/O	7/64[X]	—
C. Add time varies up to eight microseconds depending upon which memories are used. E. Additional fast memory modules may be included. K. Magnetic tapes are IBM compatible. N. 200 cpm reader and 100 cpm punch available. Q. 300 lpm printer available. Cathode ray tube display (with optional character plotting) and light pen available. X. FORTRAN II.																				
UNIVAC SS 80/90 Model I, II	$8,000 (3.6-13) $8,500[A]	1/60	85 51	3400 850 17	2.4-7.6K drum[E] .2-1.6K fast 1.2K core	10d[F] 1[G] 12.5-25	RC, WC[J]	25 10 20	240M[L] 385	600 150	500 100	600	—	—	3 9	—	—	9/63[X]		/61[Y]
A. Model II typical rental. E. STEP card and tape systems allow increments of 400 words drum and 200 words fast memory. F. Word size is 10d plus sign. G. Last part of instruction word indicates address of next instruction. J. In Model II, which will have core memory and magnetic tape, it is possible to achieve RWC with use of a second synchronizer. L. Up to ten Randex drum units (two drums) have a capacity of 24 million digits each. X. FORTRAN II. Y. COBOL '60 compiled on UNIVAC II.																				
UNIVAC 1050	$7,250[A] (5.7-9.6)	9/63	117[C]	4.5	8-32K core	1a 1	22-133[H] RC, WC	2K —	— —	1000 300	— —	700[Q]	—	√	7	—	—	—	—	—
A. System designed to be used as peripherial to UNIVAC III, 490, 1107. C. Add time assumes a five-character field. H. Numeric information can be transferred at 200,000 ch/sec. K. Magnetic tapes read in forward and reverse directions. IBM compatible tape units are available. Q. Other than special characters printed at 922 lpm.																				
PHILCO 1000	$7,010 (6-15)	6/63	39[C]	3.5[D]	8-32K core	1a[F] 1-4	16-240 RC, WC or RW	32K —	— —	2000[N] 100	1000 60	900[Q]	—	—[S]	4	—	—	I/O	—	/64[Y]
C. Add time assumes a five-character field. D. Asynchronous core banks allow increased internal speed. F. Four-character instructions operate on variable-length data fields. K. Magnetic tapes read in forward and reverse directions. N. 600 cpm reader and 200 cpm punch available. Q. 300 lpm printer available. S. Dual program control facility present. Y. COBOL '61.																				
GENERAL ELECTRIC 225	$7,000 (2.5-26)	1/61	36	18	4-16K core	20b 1[G]	15-41 MRWC	64	600M[L] 199	1500[N] 300[N]	1000[P] 110	900	same	√	96[T]	—	√	O	1/62[X]	1/62[Y]
G. Binary, decimal and double-precision arithmetic instructions included. L. Up to 32 Data Products units of 16 discs each available. Each module capacity is 18.8 million characters. N. Two 1200 MICR document-per-minute sorter-readers can be multiplexed. 400 cpm reader and 100 cpm punch available. P. 250 ch/sec reader available. T. Three index registers standard; additional 93 optional. X. ALGOL functions as a part of GECOM. WIZ. FORTRAN. Y. COBOL '61 as part of GECOM.																				
BURROUGHS B260, B270, B280	$6,500[A]	7/62	777[C]	10	9.6K core	1a[F] 3	50 none	6	480M[L] 20	800[N] 300	1000 100	700	—	—	0	—	—	—	—	—
A. Model 270, when used in proof and transit operations, has up to two six-tally registers. The card only system (B260) rents for $3,800. C. Add time assumes a five-character field. F. Instruction word is 12 characters. L. Each B472 Storage Unit has a capacity of 48 million characters, in modules of 9.6 million characters. Up to ten units may be attached. N. Two simultaneous readers available; 200 and 800 cpm in any combination. MICR documents can be read at 1560 per minute.																				
IBM 1401	$6,500[A] (2.5-12)	9/60	230[C]	11.5	1.4-16K core	1a[F] 2	7.2-62[H] none[J]	6	20M[L] 150	800[N] 250	500 150	600[Q]	—	—	3	—	—	I/O	12/61[X]	6/62[Y]
A. Typical rental for magnetic tape system. Monthly rental of a card only system is $2,500. C. Add time assumes a five-character field. F. Variable-length instructions operate on variable-length data fields. J. Normally only magnetic tape start-stop time may be overlapped with computing, but processing overlap feature permits input-output operations to overlap computing. L. IBM 1405 disc with 10 million or 20 million alphanumeric characters each. Up to five 1311 disc drives each with a capacity of three million characters are also available. Up to five 1311 disc storage drives, having total of 15 million characters, may be used. N. Optical and MICR readers available. Q. Numeric information only printed at 1285 lpm. 1404 printer used for printing on cards. X. FORTRAN. Y. COBOL '61.																				
NATIONAL 315-100	$6,000 (2.2-15)	11/64	48[C]	6	2-80K core	2a[F] 1	12 none	8	102M[L] 235	400[N] 80	600 120	650	—	√	32	—	—	I/O	11/64[X]	11/64[Y]
C. Add time assumes a five- or six-character field. F. Decimal format allows 3d word size. L. Magnetically-encoded cards on a drum (cram) permit random and sequential file processing. Sixteen units with 6.4 million alphanumeric or 9.5 million numeric characters. N. Up to four optical or MICR sorter readers may be attached. X. FORTRAN II. Y. COBOL '61.																				
GENERAL ELECTRIC 215	$5,500 (2.5-10)	/63	72	36	4-8K core	20b 1	15 MRWC	8	75M[L] 199	1500[N] 300[N]	1000[P] 110	450	same	√	96[T]	—	√	O	1/62[X]	1/62[Y]
L. Up to four disc files, each consisting of 16 discs, may be attached. Capacity of each module is 18.8 million characters. N. One 750 MICR document-per-minute sorter-reader available. 400 cpm reader and 100 cpm punch also available. P. 250 ch/sec reader available. T. Three index registers standard; additional 93 optional. X. ALGOL functions as a part of GECOM. WIZ. FORTRAN. Y. COBOL '61 as part of GECOM.																				

	Monthly Rental Typical Range	First Delivery Month and Year	Processor Speed Complete Add Time in Microseconds	Storage Cycle Time in Microseconds	Internal Storage Capacity in Words	Type	Logic Word Size Instr. Addresses	Magnetic Tape Thousands of Characters per Second Buffering Maximum Units Attachable	Random Access File Capacity Access Time in Milliseconds	Peripheral Devices Cards per Minute In — Out	Paper Tape Characters per Second In — Out	Printer Lines per Minute	Off-line Equipment Other Features Program Interrupt	Index Registers	Indirect Addressing	Floating-point Arith.	Software Algebraic Compiler	Business Compiler
RCA 301	$5,200 (3.3-25)	2/61	98[C]	7	10-40K core[E]	1a[F] 2	10-66 RC, WC, or RW	14[K] 176M[L] 100	800[N] 250	1000 100	1070[P]	same	—	3[T]	√	√[V]	I/O	6/63[X]	1/63[Y]

C. Add time assumes an eight-character field for models 354 and 355. E. A 200-character position table is used for arithmetic operations in place of adder circuits in Models 303 through 305. F. Variable-length data fields. K. Magnetic tapes read in forward and reverse directions. L. Up to two disc file Bryant units, each of four modules of 22, 44, 66 or 88 million alphanumeric characters, are available; or up to six record files of 4.6 million characters each also are available. N. 600 cpm reader and 100 cpm punch available. Optional MICR sorter/reader operates at 1560 documents per minute. P. Complete buffering available. T, V. Available with Models 354 and 355 only. X. FORTRAN. Y. COBOL '61.

BURROUGHS D250	$4,200[A] (2.8-6.7)	9/61	777[O]	10	9.6K core	1a[F] 3	— —	— —	— —	200[N] 100	1000 100	214[Q]	—	—	0	—	—	—	—

A. Generally used in banking applications, the system includes central processor, ledger processor and card reader. C. Add time assumes a five-character field. F. Instruction can be up to 12 characters in length. N. Magnetically-encoded ledger cards can be read at 180 cpm. MICR documents read at 1560 per minute. Q. 214 lpm on up to three forms.

CONTROL DATA 160A	$4,000 (2.2-9.5)	7/61	12.8	6.4	8-32K core	12b 1[G]	15-83[H] RC, WC or RW[J]	40[K] — —	—	1300[N] 100	350 110	150 1000	—	√	0	√	—	I/O	/62[X] —

G. Instructions use no-address, direct-address, indirect-address, constant-address and relative-address modes. H. CDC Model 606 or IBM 729 tape units. J. Buffered version of CDC 160. K. Magnetic tapes are IBM compatible. N. 100 and 250 cpm readers available. X. FORTRAN.

DIGITAL EQUIPMENT PDP-1	$3,600[A] (2.9-15)	11/60	10	5	4-65K core 16-131K drum	18b 1	15-90 MRWC[J]	24[K] — —	—	800[N] 100	400 63	1000[Q]	—	√	0	√	—	I/O	12/61[X] —

A. No rental prices announced. Prices derived from purchase price and do not include cost of magnetic tape units. J. Up to 16 high-speed input-output channels may be connected. K. Magnetic tapes are IBM compatible. N. 200 cpm reader available. Q. 300 lpm printer available. Cathode ray tube display (with optional character plotting) and light pen available. X. DECAL (Algol type).

PACKARD BELL PB 440	$3,500	9/63	1[C]	5 1	4-28K core[E] .2-4K biax	24b[F] 0[G]	42-62 MRWC	— —	— —	800 250	500 110	1000	—	√	—[T]	√[U]	√	I/O	/63[X] —

C. Add time variable from one to eleven microseconds. E. Biax memory is non-destructive for storage of micro commands. F. Word size is expandable to 36 or 48b. G. Instruction addresses are variable, depending on micro commands. T, U. Index registers and indirect addressing available through micro-command portion of stored logic. X. FORTRAN.

CARD VERSION OF SMALL TAPE SYSTEMS	$4,000 $2,000																		

Many of the small tape systems listed above, e.g., Honeywell 400, Univac SS 80/90, Philco 1000, General Electric 225, IBM 1401 and RCA 301, are often used only as punched-card systems and rent at substantially lower prices.

ADVANCED SCIENTIFIC ASI 2100	$3,000[A] (2.5-8)	12/63	4	2	4-32K core	21b 1	22.5-62 MRWC	32[K] — —	—	800[N] 250	500 110	400[Q]	—	√	3	√	—	I/O	/64[X] —

A. Rental price does not include cost of magnetic tape units. K. Magnetic tapes are IBM compatible. N. 200, 100 cpm readers and 100 cpm punch available. Q. 200 lpm printer available. Analog conversion equipment also available. X. FORTRAN II.

COMPUTER CONTROL DDP-24	$2,750[A]	6/63[B]	10	5	4-32K core	24b 1	15-41 MRWC[J]	16[K] — —	—	400 100	300 60	600[Q]	—	√	1[T]	√	√	I/O	/63[X] —

A. Rental price does not include cost of magnetic tape units. B. Delivered in 19-bit configuration in May 1961. J. Up to 32 program-addressable input-output channels operable in interrupt mode. K. Magnetic tape units are IBM compatible. Q. Numeric information only printed at 1200 lpm. T. Two additional index registers available as option. X. FORTRAN II augmented for FORTRAN IV.

SCIENTIFIC DATA SDS 920	$2,680 (2.5-6)	9/62	16	8 8300	2-16K core 16-96K drum	24b 1	3.5-41[H] MRWC	32 — —	—	200[N] —	300 60	300	910	√	1	√	—	I/O	12/62[X] —

A. Rental price does not include cost of magnetic tape units. H. Magnetic tape units are IBM compatible. N. Graph plotters and analog conversion equipment are available. X. FORTRAN II.

THOMPSON RAMO WOOLDRIDGE TRW 230	$2,680 (2-6.5)	6/63	12	6	8-32K core 65-262K drum	15b 0-1[F]	15-41 MRWC	16 — —	—	200 100	500 60	300	—	√	—[T]	√[U]	—	I/O	9/63[X] —

F. Instructions stored two per word when using the no-address mode. T, U. Indirect addressing, indexing and multiple-word length operations facilitated by micro-programming technique. X. FORTRAN II.

ADVANCED SCIENTIFIC ASI 210	$2,600[A] (2.3-7.5)	4/62	6	2	4-8K core	21b 1	22.5-62 MRWC	32[K] — —	—	800[N] 250	500[P] 110	1000[Q]	—	√[S]	3	√	—	I/O	4/62[X] —

A. Rental price does not include cost of magnetic tape units. K. Magnetic tapes are IBM compatible. N. Analog equipment buffer available. P. X-y plotter available. Q. 200 lpm printer available. S. Data channel traps may be set by program to ignore or recognize an interrupt. X. FORTRAN, Intercom Translator.

AUTONETICS RECOMP II	$2,500[A] (2.5-4.5)	11/58	1060	9000 950	4K disc 16 fast	40b[F] 1[G]	1.8 none	4 — —	—	20 15	600[P] 150[P]	—	—	—	0	—	√	I/O	6/60[X] —

A. Price does not include cost of magnetic tape units. F. Instructions stored two per word. G. Square root and absolute value instructions included. P. 400 ch/sec reader and 20 ch/sec punch standard, plotter available. X. SALT, SCOPAC (Fortran type).

NATIONAL 310	$2,450[A] (1.6-6.5)	4/61	12.8	6.4	4K core	12b 1	— —	— —	—	—[N] —	350[P] 110	900	—	—	0	√	—	I/O	— —

A. Price does not include cost of magnetic tape units. A version of the CONTROL DATA 160. N. Optical and MICR documents read at 750 or 1620 per minute. P. 1000 ch/sec reader available.

	Monthly Rental Typical Range	First Delivery Month and Year	Processor Speed Complete Add Time in Microseconds	Storage Cycle Time in Microseconds	Internal Storage Capacity in Words	Type	Logic Card Size Instr. Addresses	Magnetic Tape Thousands of Characters per Second Buffering Maximum Units Attachable	Random Access Bits Capacity Access Time in Milliseconds	Peripheral Devices Cards per Minute In Out	Paper Tape Characters per Second In Out	Printer Lines per Minute	Off-line Equipment	Other Features Program Interrupt	Index Registers	Indirect Addressing	Floating-point Arith.	Console Typewriter	Software Algebraic Compiler	Business Compiler
IBM 1440	$1,935 (1.5-4.5)	11/63	200[O] C	11.1	4-16K core	1d[P] 2	— — —	— — —	15M[L] 150	400 500 91[N] 150		240[Q]	—	—	3	—	—	I/O	—	—
GENERAL PRECISION RPC 4000	$1,900 (1.8-4.5)	11/60	1000	17000 10000	8K drum[E] 128 fast	32b 1[G]	— — —	— — —	— —	— —	500[P] 300[P]	—	—	—	1	—	—	I/O	/61[X]	—
NATIONAL 300	$1,850 (1.4-1.9)	5/61	11300	1200	200 core	12d 4	— — —	— — —	— —	15[N] 15	400 17	110[Q]	—	—	0	—	—	I/O	—	—
SCIENTIFIC DATA SDS 910	$1,700[A] (1.5-6)	8/62	16 A.	8 8300	2-16K core 16-96K drum	24b 1	3.5-41[H] MRWC	32 —	— —	200[N] —	300 60	300	—	√	1	√	—	I/O	12/62[X]	—
IBM 1620	$1,600 (1.6-5)	10/60	560[O] 140 C.	20 10	20-60K core	1d[F] 2	— none		8M[K] 250	250 150 125 15		240[Q]	—	—	0	√	√	I/O	12/60[X]	—
AUTONETICS RECOMP III	$1,500 (1.4-3)	6/61	1080	9300 1750	4K disc 16 fast	40b 1[G]	— — —	—	— —	20 15	300[P] 150[P]	—	—	—	1	—	√	I/O	/62[X]	—
CONTROL DATA 160	$1,500[A] (1.5-3)	7/60	12.8	6.4	4K core	12b 1[G]	15-83[H] none[J]	20K —	— —	1300[N] 100	350 110	150 1000	—	—	0	√	—	I/O	/62[X]	—
UNIVAC 1004	$1,500[A] (1.1-1.9)	9/63	112	8	961 core[E]	1a	— — —	—	— —	300[N] 200	—	400[Q]	—	—	0	—	—	—	—	—
PACKARD BELL PB 250	$1,200[A] (1.2-6)	12/60	24	3070 12	2.3-16K delay[E] 16 fast	22b 1	2 none	6 —	— —	400 —	300[P] 110[P]	500	—	—	1	—	—	I/O	5/62	—
DIGITAL EQUIPMENT PDP-4	$1,050[A] (1-)	7/62	16	8	4-32K core[E] 16-65K drum	18b 1	15-60 MRWC	8K —	— —	800[N] 100	300 63	1000[Q]	—	√	0	√	—	I/O	5/63[X]	—
GENERAL PRECISION LGP 21	$750 (.5-1.5)	3/63	7350	51000	4K disc	32b 1	— — —	— — —	— —	—[N] —	60 60	—	—	—	0	—	—	I/O	3/63[X]	—
MONROBOT XI	$700 (.7-1.5)	5/60	9000	12000	1-2K drum	32b 1[G]	— — —	— — —	— —	15[N] 15	20[P] 20	—	—	—	0	—	—	I/O	—	—
DIGITAL EQUIPMENT PDP-5	$625	10/63	18	6	1-4K core	12b 1	— — —	— — —	— —	— —	300[P] 63	—[Q]	—	√	0	√	—	I/O	—	—
H-W 15K	$355 (.35-.6)	2/63	650	16700	4K drum	24b 1	— — —	— — —	— —	45[N] 45[N]	60[P] 60[P]	—[Q]	—	—	0[T]	—	—	I/O	—	—

C. Add time assumes a five-character field. F. Variable-length instructions operate on variable-length data fields. L. Up to five 1311 disc drives, featuring interchangeable disc packs, of three million characters each. N. Punch speed is variable (91 to 360 cpm), depending on last column punched. Q. Printer speed range is 120 to 600 lpm.

E. Drum offers dual access with two read-write heads operating in two tracks, and eight words of 1000 microseconds access storage. G. The last half of the instruction word indicates the address of the next instruction. Repeat command allows up to 127 repetitions of certain basic command at 250 microseconds per word. P. 60 ch/sec reader and 30 ch/sec punch available. X. FORTRAN.

N. Magnetic ledger card stores up to 200 characters in magnetic strips. Printed information appears on front of card. Q. Programmable printer allows any columnar arrangement on forms and reports.

A. Rental price does not include cost of magnetic tape units. H. Magnetic tape units are IBM compatible. N. Graph plotters and analog conversion equipment are available. X. FORTRAN II.

C. A 300-character position table is used instead of adder circuits in Model 1 only. Model 2 features normal adder circuitry. Add time assumes a five-character field. F. Variable-word length. K. Up to four 1311 disc drives with interchangeable packs of three million characters each. Q. Printer speed range is 120 to 600 lpm. X. FORTRAN.

G. Instructions stored two per word. P. 10 ch/sec reader and 10 ch/sec punch standard, plotter available. X. AUTOCOM (Fortran type).

A. Price does not include cost of magnetic tape units. G. Instructions use no-address, direct-address, indirect-address, constant-address, and relative-address modes. H. CDC Model 606 or IBM 729 tape units. J. Magnetic tape start-stop time may be overlapped with computing. K. Magnetic tapes are IBM compatible. N. 100 and 250 cpm readers available. X. FORTRAN.

A. Rental price includes choice of either 80 or 90 column card equipment. E. Plugboard serves as instruction storage unit. N. Higher input rates (up to 400 cpm) possible when reading less than full card. Code image feature, permitting double use of each card column, optionally available. Q. 400 lpm can be maintained while printing 50 consecutive alphanumeric characters and double spacing form.

A. Price does not include cost of magnetic tape units. E. Internal storage is magnetostrictive delay lines. P. 20 ch/sec reader and 20 ch/sec punch standard while plotter and analog conversion equipment are available.

A. No rental prices announced. Prices derived from purchase price. E. Interlace storage arrangement (address locations on drum spaced according to word times) reduces drum access time. K. Magnetic tapes are IBM compatible. N. 200 cpm reader available. Q. 300 lpm printer available. Cathode ray tube display with light pen available. Analog conversion equipment available. X. FORTRAN II.

N. Card equipment to be available at a later date. X. ALGOL subset. Note. Preliminary information not verified by publisher.

G. Instructions stored two per word. N, P. Facilities for three input and three output devices, including teletypewriter, edge-punched card reader and punch, and a 16-key numeric keyboard, are available. A magnetic card input-output device is also available. Each IBM-sized card stores either 96 or 174 computer words.

P. 10 cps reader and punch standard. Q. Cathode ray display scope, light pen, and analog conversion equipment available.

N. Facilities for four input and four output devices available. P. 20 ch/sec reader and punch standard. Q. 15.6 ch/sec Selectric typewriter. T. Two index register available as option.